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COUNTDOWN ACID RAIN
GOVERNMENT REVIEW OF THE
13TH PROGRESS REPORTS
(JULY 31, 1992)
BY ONTARIO'S FOUR MAJOR
SOURCES OF SULPHUR DIOXIDE

AUGUST 1993

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by Ontario's four major sources

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EXECUTIVE SUMMARY

This is the review of the four Countdown companies' 13th semi-annual progress reports, which are required to be submitted under Ontario's acid rain regulations. Each of the four sources has met the legal limits for sulphur dioxide and acid gases (SO₂ plus NO) to date and are busy implementing their planned abatement programs to meet 1994 SO₂ emissions targets. Reports were submitted to the Minister of the Environment prior to July 31, 1992 and cover the period January 1 to June 30, 1992.

INCO LIMITED

In the first half of 1992 Inco's SO₂ emissions were estimated to be 240 kt. The mills rationalization program was completed in 1991 at a cost of about \$ 72 million and is operating properly. At present the Semi-Autogenous (SAG) mill operation is being optimized. With the process changes currently implemented, Inco's SO₂ emissions from these operations were lower by 77 kt in the first half of 1992 as compared to previous smelting technology. Inco also produced 118 kt of marketable grade sulphuric acid from SO₂ emissions captured in the new acid plant. The construction schedule shows that all planned work in the company's 6th semi-annual progress report will be completed by December 1993.

FALCONBRIDGE LIMITED

In the first half of 1992, the company's SO₂ emissions were estimated to be 32.3 kt. The company reaffirms its current operational capability to meet the 1994 annual SO₂ emissions target of 100 kt at the smelter design capacity. Phase II of the large flotation cell program was completed in January 1992. The company continues to invest capital in the Strathcona mill and smelter. These changes coupled with the research program should enable Falconbridge to meet its voluntary SO₂ emission target of 75 kt before 1998. The R & D effort is focussed on higher pyrrhotite rejection in mineral separation, electric furnace developments and planning a high degree of roast test demonstrations.

ALGOMA STEEL CORPORATION

Algoma's SO₂ emissions from its sinter plant at Wawa were estimated to be 17.4 kt in the first six months of 1992. The report indicates that the company plans to use lower sulphur iron oxides, mill scales, and other iron/steel industry by-products as sinter plant feed to lower SO₂ emissions from this facility. This should help to maintain SO₂ emissions substantially below the 1994 limit of 125 kt.

ONTARIO HYDRO

Ontario Hydro's SO₂ and acid gas emissions were estimated to be 105 kt and 140 kt in the first six months of 1992. Both SO₂ and acid gas emissions were higher by 32 percent than Hydro's 1991 emissions for a similar period. The main factor contributing to

increased acid gas emissions was lower nuclear performance which resulted in an additional 28 percent fossil electricity generation. In the first half of 1992, Hydro spent \$197 million on measures contributing to acid gas control. The Lambton and Nanticoke stations flue gas conditioning (FGC) systems have been declared in-service. The Lambton flue gas desulphurization program is on schedule and commissioning is planned for early 1994. Hydro is also participating with other U.S. utilities in evaluating the application of the Selective Catalytic Reduction (SCR) technology for NO_x emissions control at North American coal fired power plants.

INTRODUCTION

Four major corporate sources (Inco, Falconbridge, Algoma at Wawa, and Ontario Hydro) produce over 80% of Ontario's sulphur dioxide (SO₂) emissions. Each source is required by Ontario's Countdown Acid Rain regulations to report every six months on the progress made to reduce SO₂ emissions.

The Countdown program was formulated in 1985 and placed an annual SO₂ emissions cap of 885 kt (Ontario is considering to lower its SO₂ emission cap to 877 kt in order to meet the Federal/Provincial agreement of 1985 among 7 eastern provinces to collectively cap SO₂ emissions from these provinces to 2.3 million tonnes after 1993) on all sources in the province, to be in place by 1994. Specific reductions in SO₂ for the four companies began in 1986 and culminate in a cap totalling 665 kt by 1994. In the case of Ontario Hydro, limits were also placed on the combined emissions of SO₂ and nitric oxide (NO) and an interim cut of 35% limiting SO₂ to 240 kt and acid gases (SO₂ + NO) to 280 kt was also imposed for 1990-1993. The Countdown limits are in addition to standards imposed to ensure good ambient air quality. Annual legal limits are summarized in Table 1.

Table 1
Sulphur Dioxide Legal Limits
(thousands of tonnes per year)

	<u>1985</u>	<u>1986</u>	<u>1990</u>	<u>1994</u>
Inco nickel/copper smelter, Sudbury	728	685	685	265
Falconbridge nickel/copper smelter, Sudbury	154	154	154	100
Algoma iron ore sintering plant, Wawa	285	180	180	125
Ontario Hydro fossil fuel power plants, province-wide	390	370	240	175
Legal Limits Sub-total :	1,557	1,389	1,259	665

Each of the four sources has met the legal limits to date and each has submitted detailed plans for implementing its reduction program, as required by the regulations. The sixth set of company progress reports, received in December 1988 and January 1989, set out the detailed methods and schedules for meeting the emission limits of the Countdown regulations. They were accepted by the government.

Implementation progress reports are required every six months. This document summarizes the contents of the 13th set of semi-annual company reports and the government response. Previous semi-annual reports are available from the Public Affairs and Communications Services Branch, Ontario Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario, M4V 1P5, (416) 323-4321.

COMPANY REPORTS AND GOVERNMENT RESPONSES

The progress reports were reviewed by a technical working group drawn from the Ontario Ministries of Environment, Northern Development and Mines (for the metallurgical companies) and Energy (for Ontario Hydro).

The implementation phase of the Countdown program is now well under way, and each of the four regulated companies reports its progress and current status in relation to the 1994 emission limits. A summary of the individual reports and the Ontario government's response follows.

INCO LIMITED

Regulation 660/85 requires a reduction in annual SO₂ emissions from Inco's nickel/copper smelter complex in Sudbury to no more than 265 kt for any year after 1993, compared to the current limit of 685 kt per year. The company was also required to examine the feasibility of going beyond the current limit of 265 kt by 1994 to a level of 175 kt at some future date.

Consequently, the feasibility of continuing technical advances remains a concern of Inco and of the government. The government previously accepted Inco's position that a specific interim reduction was not feasible because of the nature of the major process changes being undertaken in order to meet the 1994 emission limit.

Company Report

The company's 13th progress report covering the period January to June 1992 indicates that:

- Implementation of the Sulphur Dioxide Abatement Project (SO₂ AP) is continuing as detailed in the report of December 1988 to meet the annual SO₂ emissions target of 265 kt after 1993. Smelter SO₂ AP costs have been budgeted for \$ 520 million with total SO₂ Abatement Program to cost about \$ 600 million.
- The mills rationalization program was completed in 1991. However some fine tuning of the Semi-Autogenous (SAG) mill is still to be completed. Inco has indicated earlier to the Countdown Technical Support Group (CTSG) that full benefits of this program will be realised when bulk concentrate smelting is totally operating in 1994.
- The construction schedule shows that all planned work detailed in the company's 6th semi-annual report (December, 1988) will be completed by December of 1993. The report also indicates that about 80 % of the Smelter Construction Program is schedule for completion by the end of 1992.
- Financial commitments of about \$ 511 million as of April 30, 1992 have been made for the SO₂ AP. This is approximately 86% of the total estimated revised project cost.

- Smelter SO₂ AP expenditures to-date total some \$441 million, about 85% of the revised project costs of \$520 million.
- The overall engineering has progressed to 98 % of completion. The project engineering is on schedule and will be 100% complete by December 1992.
- As of June 1992, some 108 engineering and construction management personnel were working on the project. In addition to this, more than 270 trades personnel were involved in on-site contract work.
- The first of the two new oxygen flash furnaces, together with major ancillary facilities, was commissioned in October 1991. Up to July 31, 1992, Inco processed 199 kt of nickel concentrate through the new flash furnace.
- At the end of December 1991, the new flash furnace still had some problems due to higher than desired matte grades (50-55% nickel and copper), and high metal losses in slag. The new flash furnace operation also caused higher offgas and slag temperatures, and lower matte temperatures. These operating conditions resulted in matte tapping difficulties and furnace wall brick erosion. These problems are reported to have been remedied and Inco is confident that the new flash furnace is operating properly.
- With the process changes currently being implemented in the nickel and copper smelting circuits, some of which are up and running, Inco's SO₂ emissions from these operations were lower by about 77 kt or 23 % in the first half of 1992. Inco also produced about 118 kt of marketable grade sulphuric acid from SO₂ emissions captured in the new double contact acid plant.
- Inco's SO₂ emissions for the first half of 1992 were 240 kt.

Government Review

The government review concluded that Inco continues to meet the requirements of Regulation 660/85. Representatives from Inco Ltd., and the Ministry's Regional/District staff met in September, 1992 to review and discuss some of the concerns arising out of the 13th progress report (July 31, 1992).

The main areas of discussion at this meeting were as follows:

- Modifications to flash furnace operation
- Copper Sulphide (MK material) reactor design changes
- SO₂ emissions for 1st half of 1992
- Overall program schedule

Mills Rationalization

- The Ministry wishes to be appraised of Inco's progress in resolving the difficulties experienced with the SAG mill.

Smelter

- The Ministry is concerned about the new flash furnace operating problems encountered by Inco in the first four months of 1992. Although most of these problems appear to have been resolved, the CTSG members are concerned about the recycle of clean SO₂ bearing off-gases to the flash furnace and its possible impact on sulphuric plant operation. The Ministry wishes to be appraised of this matter in the next progress report and of the optimization of Phase I of the SO₂ AP.
- The Ministry is also concerned about high copper dust emissions from the pilot MK reactor which has forced Inco to develop an alternate smelting method for MK concentrate using direct injection of MK material through tuyeres and stirring the molten material in the reactor with nitrogen gas injected from bottom porous distributors. Although the report indicates that the MK reactor design is proceeding to allow these changes to be implemented any further delays in MK reactor in-service dates could likely have a major impact on Inco's nickel/copper production in 1994 in order to meet the annual SO₂ emissions limit of 265 kt.

Acid Plant

- The Ministry is pleased to note that Inco's new double contact acid plant is operating well and has produced 118 kt. of marketable grade sulphuric acid from January to June 1992.
- Although the Company's efforts in attempting to find a reliable sulphur trioxide (SO₃) analyzer for continuous monitoring of SO₃ concentrations in the tail gas stack have not been successful, company representatives were advised that CANMET is currently developing a SO₃-SO₂ dual sensor which, if successful, could be commercialized within 2 to 3 years. Inco should regularly check SO₃ concentration in tail gases to ensure that the SO₃ absorption system is working properly and prevent any SO₃ spills.

FALCONBRIDGE LIMITED

Regulation 661/85 requires Falconbridge to reduce its annual SO₂ emissions from its Sudbury nickel-copper smelter complex to no more than 100 kt after 1993. The regulation also requires Falconbridge to evaluate the possibility of reducing SO₂ emissions below the 100 kt per year level. Promising areas for further reductions have been identified by the company.

Company Report

The 13th progress report, covering the period January to June 1992, notes that:

- The company reaffirms its current operational capability to meet the 1994 annual SO₂ emission limit of 100 kt at full smelter production capacity. This emission reduction achievement was the result of technical and operational developments by the company such as improved pyrrhotite rejection, increased degree of roasting and sulphuric acid production, enhanced slag cleaning operation, separate copper concentrate production, and increased smelting of recycled materials supplemented by custom feed.
- Falconbridge will continue to invest capital in the Strathcona mill and smelter. The company anticipates that this investment, coupled with the research program will enable it to meet its voluntary SO₂ emission target of 75 kt before 1998.
- In the first half of 1992 the company emitted 32.3 kt of sulphur dioxide. This is approximately 8.7 % of the sulphur in the nickel/copper ore.
- The report also indicates that the capital budget for the process modifications over the period 1989-1993 is estimated at \$32.7 million for capital projects and in excess of \$8.0 million for research and development. In 1992, \$1.4 million will be spent on capital projects in the roasting, acid plant, smelting and converting areas.
- During 1991, capital projects in the smelter area amounting to \$2.9 million were completed and planned changes to the roasters, acid plant, electric furnaces, and converter areas are estimated to cost \$2.5 million in 1992.
- Some scope changes to the original plan were made and these cover the acid plant absorbing tower modifications, electric furnace off-gas ducting modifications, and the removal of the acid plant booster fan. All planned smelter modification projects are expected to be in service before the end of 1993 per the current schedule.

- Research and Development work in this period focused on electric furnace developments as well as on planning for high degree roast tests demonstrations.
- The report states that the upgraded regrind circuit is slated for commissioning in August 1992 and the magnetic separation circuit on rougher concentrate is scheduled to be in operation by November 1992. Phase II of the large cell program was completed at a cost of \$ 1.9 million in January 1992.
- These two projects are expected to cost \$1.75 million and \$1.1 million respectively and when fully completed and operational are expected to provide improved process control and sufficient space to install pyrrhotite rejection circuitry.
- The mineral processing research and development program continues to make progress at pilot plant level at the Strathcona Mill and alternative reagents and flowsheets to further improve pyrrhotite rejection are being evaluated.

Government Review

The Countdown Technical Support Group (CTSG) concluded that the company's 13th semi-annual progress report met the requirements of Ontario Regulation 661/85 and that the implementation of the SO₂ abatement program is progressing on schedule. The CTSG is pleased with the technical progress Falconbridge has achieved in meeting its SO₂ emissions limit of 100 kt at full smelter production capacity three years ahead of schedule. The CTSG is further encouraged to note that the company's further investments in R & D and capital projects will likely enable Falconbridge to achieve its goal of SO₂ emissions level of 75 kt/yr earlier than 1998.

Additional comments are as follows:

- The company has responded satisfactorily to queries from the previous government reports.
- There were no new concerns or issues in this report about the company programs to meet the 1994 SO₂ emissions target.
- The Government's concerns raised in the 11th Semi-Annual Progress Report (July, 1991) have been addressed satisfactorily.
- The flowsheets on various process changes and sulphur balance provided in semi-annual reports are helpful in understanding

reported changes by the company and in following the progress of the company's SO₂ Abatement Program.

- CTSG members are also pleased with the company's research and development efforts, in these difficult economic times, to continue moving towards its voluntary annual SO₂ emissions target of 75 kt before 1998.

ALGOMA STEEL CORPORATION

The Algoma Steel Corporation (ASC) operates an iron ore sinter plant at Wawa, about 270 km northwest of Sault Ste. Marie. Regulation 663/85 limits current SO₂ emissions from the operation to 180 kt per year, dropping to no more than 125 kt per year for every year after 1993.

In August 1986, the sinter production capacity at Wawa was downsized by about 50 per cent. When combined with reduced sulphur level in the feed, this has resulted in substantially reduced SO₂ emissions.

Company Report

The company's 13th semi-annual progress report covering the period January to June 1992 confirms that the company will meet the 1994 SO₂ emission limit by the reduction of sinter capacity. In addition, continued and possibly increased use of low sulphur iron oxides at Wawa could further reduce the level of SO₂ discharged from the sinter plant.

The 13th semi-annual progress report also indicates that:

- In the first half of 1992 Algoma's SO₂ emissions were 17.4 kt due to lower sinter production by about 30 % compared to similar period in 1991 when 641 kt of sinter was produced.
- The company's earlier forecast suggested 1992 SO₂ emissions of about 47.7 kt, at a sinter production capacity of 1.05 million tonnes.
- The company plan indicates that use of lower sulphur iron oxides and mill scale in sinter plant feed will be continued and this should help to maintain low SO₂ emissions, substantially below the 1994 limit of 125 kt.

Government Review

- The CTSG concluded that the company continues to meet the requirements of Regulation 663/85.
- No changes have been reported in the company's plans to meet 1994 SO₂ emissions target of 125 kt.

- The company shall also provide in their semi-annual progress reports SO₂ emissions for the appropriate period and general comments on production activity at its Wawa sinter plant.

ONTARIO HYDRO

Regulation 281/87 requires Ontario Hydro to meet interim 1990 emission limits and imposes a tighter limit for 1994 and beyond. Separate limits are set for SO₂ alone and for the sum of SO₂ plus NO (nitric oxide), as shown in Table 2.

Table 2
Ontario Hydro's Sulphur Dioxide and
Acid Gas Emissions Limits

<u>Period</u>	<u>Regulated Limits</u>	
	<u>SO₂</u>	<u>SO₂ + NO</u>
	(kilotonnes per year)	
1986 to 1989	370	430
1990 to 1993	240	280
1994 and future	175	215

Company Report

The corporation reports that in the first six months of 1992 acid gas emissions were estimated at 105 kt of SO₂ and 140 kt for SO₂ plus NO, respectively. Both SO₂ and acid gases emissions were higher by 32 % than Hydro's 1991 emissions for similar periods due to technical problems at the nuclear generating plants.

The corporation reports expenditures during January to June 1992 of \$197.0 million on measures contributing to the reduction of acid gas emissions, as follows:

- \$ 70.3 million was spent for flue gas desulphurization for the Lambton Thermal Generating Station.
- \$0.8 million was incurred for flue gas conditioning at Lambton, Nanticoke, and Lakeview. This measure allows Hydro to burn low sulphur coal at these locations until suitable control measures, e.g., Flue gas desulphurisation (FGD) scrubbers are installed.
- \$2.4 million was spent for combustion process modifications.

- \$120.0 million was spent for a low sulphur coal premium, which was partially for acid gas control. This is approximately 77% of the total expenditure reported by Hydro for acid gas control in this report.
- \$2.2 million for compliance with the emissions verification and reporting order issued by the Ministry in June, 1990.
- \$0.7 million for research and development.
- The report also indicates that the cost of installation of two FGD scrubbers using a limestone slurry system at Lambton has increased by \$80 million over an earlier estimate of \$457 million. The increase in FGD scrubber project costs is due to higher tender prices, higher interest rates, some changes in project scope to include support facilities, site and relocation of services and commissioning and operating expenses. In spite of the scope changes, the FGD program is on schedule and the two Lambton scrubbers are expected to be in-service by early 1994.
- The 13th semi-annual progress report also indicates that the installation of the flue gas conditioning (FGC) equipment with sulphur trioxide (SO_3) and ammonia (NH_3) conditioning agents has been declared in-service for all units at Lambton and Nanticoke. The problem of derating of Nanticoke boilers by about 5.0 % when fired with blended coal having less than 0.6 % sulphur still exists. Hydro engineers are working on this problem.
- SO_3 injection systems were installed for units 5 and 6 at Lakeview during major outages. No stack testing was conducted in the first half of 1992 to generate NO_x vs load curves. However, Hydro plans include the testing of four representative units before December 1992.
- Hydro's current plans to implement combustion process modifications (CPMs) for all units at Lambton by 1998. This will result in an additional 30% NO_x emission reduction from this source. Hydro plans to participate with other U.S. utilities to evaluate SCR (selective catalytic reduction) technology for U.S. and Canadian coals and is also evaluating urea injection for NO_x emissions reduction.
- Hydro also participated in the development of a new NO_x standard for utility boilers under Environment Canada's initiative (CCME N-305) and combustion turbine NO_x emissions (CCME N-307).
- A recent update of Hydro's Demand/Supply Plan (January, 1992) indicated that Hydro plans to extend the life of fossil fuel generating stations. Life extension work would include new environmental controls such as FGD, SCR and enhanced particulate control for Lambton and Nanticoke to lower adverse environmental impacts from SO_2 , NO_x and air toxics.

- Hydro is also studying the potential for NO_x emissions trading for stationary sources in the Ontario portion of the Windsor-Quebec Corridor (WQC) through a multi-source advisory group made up of industry, government and non-governmental organisation representatives to reduce ground level ozone exceedences in the air shed.

Government Review

Some points noted by the reviewers are listed below:

- The Countdown Technical Support Group (CTSG) concluded that Ontario Hydro's 13th semi-annual progress report meets the requirements of the Regulation 281/87.
- The explanation provided by Hydro regarding the increase in Lambton FGD scrubber project by about \$80 million as a result of detailed engineering costing and some scope changes looks reasonable.
- The CTSG is pleased to see that Hydro plans to install combustion process modifications at its Lambton facility which would help to lower NO_x emissions; but Hydro's earlier plans also referred to further modifications to Nanticoke in order to obtain an additional 15 % NO_x emissions reduction at this source. The Ministry would like to be appraised of this in the next semi-annual report.
- Although the CTSG is reasonably satisfied with the reasons provided for increased acid gas emissions in the first half of 1992 compared to the similar period in 1991, the Ministry is also concerned about Hydro's problems at the nuclear generating facilities.

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